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EDITORIAL.

ENGINEERING ITEMS.

Vast Bridges.—The contemplation and discussion of engineering works of unusual magnitude, is at all times a subject of some interest, and when the plans proposed are the work of well-informed and judicious engineers, they may be of much service as suggestions and a means of developing special information. At present the subject of far-reaching bridges seems to be uppermost in the minds of the engineering community all over the world; and among the various grand projects put forth, some may even hope for a realization at no distant date.

An account of the proposed bridge over the East River at New York, was given by our esteemed correspondent in that city in our number for June, and we may expect soon to witness in that locality a practical illustration of the great problem involved.

In the last number of *Engineering* which we have received (August

23d), we find a very interesting account of the plan proposed by M. Oudry, of the Corps Impériel des Ponts-et-Chaussées, for a suspension bridge over the Straits of Messina.

The width of the Straits is about 10,500 feet at the narrowest portion, but to secure the least depth of water for the foundation of the piers a line would be chosen of 13,123 feet in length from shore to shore.

On this line the depth of the piers would be 360 feet, while on the other line they must have gone down 426 feet below the water level. Even the lesser of these depths is sufficiently formidable. The height under the spans would be, furthermore, 164 feet, which would allow all ordinary vessels to sail under unimpeded, and the largest vessels of war to pass, by striking their top-gallant masts.

This would give the total height of the piers, from foundation to flooring of bridge, at 524 feet. The length of the spans would be 3281 feet or 1000 metres each.

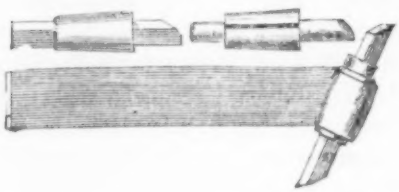
In the *Mechanics' Magazine* for July, page 50, we find also an excellent account of the plan for a bridge across the English channel which has been proposed by Mr. E. R. Jones, an English engineer, whose design may be briefly described as follows:

A construction bed or platform should be prepared on either shore at the level of extreme low tide, and on these there should be built large masses of brick and Portland cement, faced with granite, such as may be seen on a smaller scale at the Admiralty pier, Dover. These blocks, when fully consolidated by the intermittent action of the salt water, at successive tides, would be floated off by strong pontoons, and lowered at once on the sites selected for the several piers. If the blocks were about 60 feet long, 40 feet wide and 20 feet high, they would weigh in air about 3000 tons, or, immersed in water, but 2000 tons, and might be well managed by a pair of 1500-ton pontoons, provided with the necessary motive power and machinery. Eight such blocks superposed would bring a pier up to high water mark, while their great weight would defy displacement by the most violent waves.

A lighter structure could be erected upon these subaqueous foundations, and carried to the requisite height for the road platform. The narrowest part of the channel is 20 miles in width. Placing piers 500 feet apart, 200 piers would be required. These, by the process above described, it is calculated, could be built in less than four years, and if the superstructure was made to follow them up promptly, the

bridge might be finished in that time, and at an estimated cost of only £5,000,000. On such an outlay the estimated business would make a handsome profit.

Improved Tool-Holder.—This arrangement consists of a bar or rectangular shaft of wrought iron, which may be supported in the slide rest of the lathe in the same manner as the shank of an ordinary cutter. At the outer end this bar terminates in a conical cylinder inclined at such an angle as is generally given to a cutting tool. In this conical cylinder the tool (which is simply a bar of steel of such section as is necessary, dressed off obliquely at one end to make the cutting edge) is secured by a slightly elastic conical thimble almost fitting the tool, and grasping it firmly when driven into the cylinder by a light blow. This tool-holder is patented by Cooper, manufactured by Hoxie & Tolls, and sold by H. Baragwanath & Co., No. 158 Read Street, New York.



The Wilson Furnace.—In a late number of *Engineering* we find an editorial notice strongly endorsing the above apparatus, the opinion expressed being chiefly founded on the results of very thorough experiments lately tried at the Bolton Iron and Steel Co.'s Works, where this furnace has been puddling 20 cwt. of blooms from 21½ cwt. of pigs, and this with only 1 cwt. of coal.

In the above article it is stated that "The Wilson furnace is the most extraordinary invention yet brought out, saving nearly if not quite half the fuel commonly employed for the very same purpose." Under these circumstances we think a description from material supplied in previous numbers of the above journal will be of interest.

The peculiarity of this furnace is, in the first place, a downward draft through the mass of fresh fuel, by which means, in place of having the fresh supply thrown on the hottest part of the fire, so as to give up its gaseous portions in a hasty and spasmodic manner, to the great detriment of the flame produced, and the evolution of wasteful smoke, it is gradually cooked and burns, *seriatim*, first its gaseous then its solid constituents. To obtain this result, the furnace is constructed of a short vertical flue, into which the fuel is thrown from above, closed at the top, but with doors or registers to admit a supply of air. The fuel settling by gravity down this sort of "hopper," comes

upon a sloping plate and then upon the grate-bars, through which a further supply of air is admitted, and the cinders and ashes are withdrawn. Other air-openings are also provided, in some forms, for admitting draft at other points, as, for example, over the fire, when highly bituminous coals are employed.

The conspicuous merit of this furnace in its working, seems to be the perfect regularity with which it keeps the chamber full of flame, bathing the whole in a constant flow of mellow heat.

Boiler Explosions.—While in 1866 about seventy-five boiler explosions occurred in Great Britain, but sixteen have been reported for the first half of 1867.

The New Graving Dock at Malta was initiated by the laying of the corner-stone 41 feet below the sea-level on the first of August.

This dock, as described, will be the largest constructed. Its length on floor will be 430 feet, and coping 468 feet. Width of floor, 42 feet; width at broad altar, 84 feet; width at coping, 104 feet. Depth, 39 feet, and on sill 33 feet 6 inches.

A Novel Grading Machine is at work on the Fox (Ill.) Railroad. It consists of a plough, with apron and gearing for carrying the earth up and depositing it in the centre of the road-bed. It is worked by four horses and two men, and will do the work of thirty men in grading.

The Iron Mines at Marmora, in Canada, which were recently opened, are yielding large quantities of ore. It is only three weeks since shipments commenced, and already six thousand tons of ore have been shipped from Coburg to Cleveland or Erie—mostly to the latter port. The company are now shipping over three hundred tons per day.

The Alps no longer separate Italy and Germany.—The first locomotive has crossed the mountains, and Venice is thirty-five hours from Frankfort.

Apparatus for Embossing Metal Tubes.—The important feature of this arrangement is the introduction, within the tube to be treated, of a mandrill having a roller so supported within it that by the motion of a wedge or "expander," (controlled from outside,) it, the roller, may be made to project from the mandrill and exert a pressure on the tube, by which the latter is expanded at that point and pressed into the cavities of a surrounding die. This machine, and its various modifications, are fully explained in the *Mechanics' Magazine* for July 12th, 1867.

Apparatus for Drying Tan.—Many of our readers are aware that in the crushing rolls, used in the sugar mills for extracting the juice from cane, the dessication of the latter is so complete that the begasse, or crushed canes, may be fed at once to the engine fires, being as "dry as chips," or as seasoned wood. This mode of drying has now, we see, been applied to refuse tan with good effect as regards economy in time and labor, as compared with the usual method of spreading out and raking over to promote atmospheric evaporation.

NOVELTIES IN CHEMISTRY AND PHYSICS.

Sulphurous Acid on the large scale may be easily produced by heating together sulphate of iron and sulphur, the reaction being as follows: $FeO, SO_3 + 2S = FeS + 2SO_2$. Two and a half parts of dry sulphate are mixed with one part of sulphur.

The Theory of Grove's Gas Battery has lately been discussed in the French Academy, where M. Gougoin maintains that it is not essential, as Grove stated, that each of the platinum elements should be at the same time in contact with the gas and liquid, but that the office of the gas reservoir is simply to keep the liquid in a state of saturation.

Heat developed by electric current in wire is partly due to molecular action. This proposition has been, to some extent, demonstrated by M. E. Edlund, who finds that the elongation of a wire traversed by a current is greater than its temperature, deduced from its electrical resistance, would develop. He therefore concludes that a molecular change of some sort has occurred by which the additional increment of heat has been produced.

For Cleaning Type and Woodcuts from printers' ink after use, benzine and other light products of distillation from coal oil, are found much more effective than any of the materials previously employed for a like purpose, as we learn from the *Mechanics' Magazine*, page 34.

The Power and Persistency of the Bunsen Battery may be augmented, as we learn from the above source, by an arrangement devised by M. Zaliwski, which consists in employing two concentric porous vessels in place of one, filling the space between them with sulphuric acid, putting nitric acid in the central one, and a solution of sal-ammoniac in the outer vessel containing the zinc.

Copper Deposited by Galvanic Action is rendered *tough*, according to M. Bouillet, if a mere trace of gelatine be added to the solution of sulphurate used in its preparation.

A New Kind of Artificial Stone has been invented by M. Sorel. It is prepared by combining a saturated solution of chloride of magnesium with calcined magnesia. Billiard balls and ornamental objects are made with this, and a thinner paste of the same material serves to consolidate twenty times its weight of sand and similar material for the formation of tiles and flags or other rougher articles.

The Physical Constitution of the Sun.—Under this title M. Stoney treats of numerous questions interesting to cosmical science.

In his opinion the atmosphere of the sun on the exterior surface is a mixture of numerous gases, chiefly hydrogen, sodium, magnesium, calcium, chromium, manganese, iron, nickel, cobalt, zinc and barium. These gases may be considered as permanent, on account of their high temperature. In that atmosphere, hydrogen being the lightest gas, would ascend furthest from the centre, and the rest in the order of their densities, barium being the last.

These gases are relatively opaque, and, emanating in a state of incandescence, determine the spectrum. In consequence, the rays coming from the interior of each shell of gas, do not traverse that shell, but those which emanate from the exterior surface traverse all the masses which envelop them. On the other hand, the heat of the rays which emanate from those masses nearest the centre is also very intense, as is demonstrated by observations. The rays of hydrogen, of sodium and magnesium, proceed from a region relatively so cold that the lines which they furnish in the solar spectrum are exceedingly obscure, and the contrary is the case with those gases at the interior. M. Stoney concludes, from the comparison of the lines of the spectrum, as regards their luminous intensities, that hydrogen and iron constitute those bodies which are the *most* exterior at the surface of the sun, and that these two elements appear to play the same part as hydrogen and oxygen in the terrestrial atmosphere.—(Trans. from *Les Mondes*, vol. xiv., page 604.)

New Map of the Moon.—We extract from the London *Athenæum* the following account, which is of special interest in connection with the curious observations seeming to prove the fact of a late volcanic eruption in our satellite, which we gave at some length on page 76 of this volume.

"The Lunar Committee of the British Association have just issued

two sections of their map on a scale of 220 inches to the moon's diameter, comprehending two areas of 24 superficial degrees, which are equal to 17,688 square miles English in the two. On these sections, printed red, the plains, craters, mountains, valleys and other objects are laid down in outline, each known object being distinguished by a reference number to the text which accompanies the two sections, and which treats, first, of the materials used in constructing the map; secondly, the arrangement of objects in zones for facilitating observation; thirdly, the kind of observations to be made for perfecting the work; fourthly, a descriptive catalogue of two hundred and three known objects; fifthly, the full moon aspects; and, sixthly, copious tables of the lines of disturbance on the two areas. The portion of the moon embraced by the sections extends 6 degrees westerly from the first meridian, and 10 degrees southwardly from the equator; the portion of Beer and Madler's map is given in a plate accompanying the text.

"Photographs taken by De La Rue and Rutherfurd, under different states of libration and illumination, have contributed very materially to the determination of outline and the insertion of small objects not discernible under the high illumination of the moon. Several of the smaller objects have been inserted from telescopic observation. The whole of the work has been executed independently of the labors of previous selenographers, with the exception of points of the first order and a few special instances, and after engraving it has been compared with Eldermann's sections.

"It is especially stated in the text that the map is not intended to be perfect or complete, but merely a guide to observers in obtaining data for constructing a complete map of the moon. For this purpose numerous observations are essential, and with a view to accomplish it, the areas are divided into zones of 2 degrees of latitude in each, which are so allotted that every zone of 1 degree may be examined by two independent observers, the ground of each overlapping and dove-tailing into that of the other; and it is recommended that each object specified in each zone of 2 degrees be examined by the observers to whom the zones are allotted when they are near the morning and evening terminators, and also on the days succeeding and preceding the passage of the terminators over the areas—through a period corresponding to at least three lunations—and a record kept of the appearances observed, measures taken, and other remaks appertaining to each object, such record to be transmitted in due course

to the Lunar Committee of the British Association. The zones are now in process of allotment.

"The intention of this examination is to endeavor to fix, by the aid of two independent observers, the exact state of a designated lunar object at a given epoch; for if, from the observations in a given zone, the characters and appearances of the object in that zone can be settled beyond dispute, from the testimony of two witnesses, and authoritatively published by such a body as the Lunar Committee, it follows that the record so published can be referred to at any future time, and the question of fixity or change of any of these objects during the interval definitely settled. The observations referred to in the text are the identification of objects, and the correction of position or outline of those inserted and catalogued by the aid of admeasurement. It is also recommended that careful drawings of particular spots, or groups of objects, in each zone, be made and forwarded to the Committee, together with notices of the earliest detection of objects not inserted in the map or catalogue."

Discovery of a New Planet.—Professor J. C. Watson, of Ann Arbor, Michigan, announces the discovery of a new planet, hitherto unknown, which was first seen by him last night. It is situated in right ascension 1 degree and 40 minutes, and in declension 3 degrees and 10 minutes south, and is moving west and south.

Charcoal as a Water-Filter.—Recent experiments upon the action of charcoal in removing organic matter from water, confirm the established conclusion that its purifying effects depend less upon mechanical absorption than upon oxidation. Thus, twelve gallons of water containing 10·80 grains of organic matter per gallon being filtered through a certain quantity of freshly burned charcoal, four and eight-tenths grains were removed from the first gallon, but the amount removed gradually decreased, until, after the sixth gallon, the charcoal began to return the impurities extracted from the water at first. The quantity returned to the twelfth gallon amounted to 1·5 grains. As the efficacy of charcoal in purifying such water depends upon oxidation, as above stated, the atmospheric oxygen should be allowed free access when the organic matter, arrested by the charcoal, will be oxidized by the oxygen also absorbed by the same body.

Cantharidin.—Prof. Dragendorff has found in cantharides a volatile body which acts on the organism in a similar manner to cantharidin. Freshly powdered cantharides are moistened with water and distilled; the portion going over below, and at 100° C., which

has an acid reaction, contains the new body.—(*Chemical News*, Vol. I., No. 2.)

Minute Globules found in the Flue-dust of Blast Furnaces.—Mr. J. B. Dancer, in a paper read before the Manchester Literary Society, drew attention to some very curious and pretty spherical globules found in the flue-dust of blast furnaces. Many of these globules are turned as smoothly as a billiard ball, with a high polish. Some are transparent, others opaque and brilliantly colored, while some are mere perforated shells. Many are of a rusty brown color, resembling cannon balls, and are probably ferrous oxide, formed by the action of heat on the iron pyrites in the coal. There are also balls of black magnetic oxide. The perforated shells are probably ferrous sulphides. The globular form is probably due to their being thrown off as scintillations in the furnace, and assuming the spheroidal form while in a liquid state, as they are carried along by the draft.

Editorial Correspondence.

STEAM-BOILER EXPLOSIONS.

NEW YORK, *August 28th*, 1867.

To the Editor of the Journal of the Franklin Institute.

SIR: In your August number, I notice an article from the *London Mechanics' Magazine* "On Overheated Steam Boilers," giving an account of some experiments made, in order to prove the non-explosiveness of boilers heated red-hot, and then having a sudden jet of cold water let into them.

It seems to me that these trials were not carried to a satisfactory conclusion; a perfectly empty and red-hot boiler seldom or never occurs in practice. The parties making these trials should have first put some water in their boilers, made it *all into steam* as hot as they liked, and then let in the jet of cold water. The effects would then, I think, have been *very different* and more in accordance with what actually occurs through carelessness, in not keeping a proper gauge of water in a boiler.

Very respectfully,

R. W. NEWBERY.

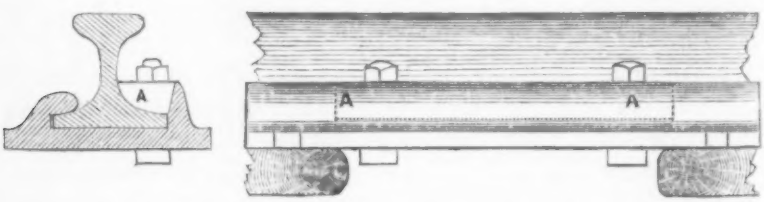
The precise experiment described by our correspondent was tried

by the Committee of the Franklin Institute, appointed to investigate the cause of steam-boiler explosions, and is described in the reports of the same, published in this *Journal* for 1836 and '37. The results obtained were in no respect different in general bearing from those above alluded to.—Ed.

OUR NEW YORK LETTER.

New York, *August*, 1867.

Gradually our American roads are adopting steel rails, and with such satisfactory results that there is now a positive confidence in their use, such as test and experience alone can give. One of our leading roads, we understand, is buying no more iron rails at all, so satisfied are its directors with the proved superiority and economy of steel ones. The road (the Hudson River) has now in use some thirty mile of steel rail, made by Chas. Cammell & Co., of Sheffield, weighing about fifty-six pounds per yard in thirty feet lengths. Between Thirtieth Street and Spuyten Duyvil Creek, a distance of ten miles, there have passed over these rails, from November 1st, 1866, to August 1st, 1867, 445,000 wheels, independent of 4175 engines. The wear caused by this heavy traffic is unappreciable, and the rails appear as good as when first laid down. The ends of the rails are barely flattened where the bolts of the chains had not been screwed down tight enough to hold them in place. The pattern of chain now in use along the whole line of this road, was one devised by Mr. A. F. Smith, the able superintendent of the line and well-known mechanical engineer. The annexed drawing shows the arrangement. An



end and side view are there presented. The chain itself is really a long Phœnix chain, so as to rest upon two ties and thus distribute the bearing. The left side is turned over to fit the base of the rail, leaving about a sixteenth of an inch play to allow of crowding, which is effected by means of the splice bar, *a*, and the two screw-bolts, as shown. The right-hand lip is slightly inclined outwards to aid the wedging action of the splice, besides giving great rigidity in its action

as a girder. The web of the rail, it will be noticed, is *not turned* as is the case with most other suspension joints, which would weaken the weakest part of the rail, the base being merely cut, as for an ordinary spike hole.

The above rails are laid, perhaps, in the most unfavorable manner, the joints being laid on the same tie, instead of being broken. I am aware that Engineers differ as to this; but my own experience and observation goes to show, that where one tie catches the whole force of the joint blow, an increased settling in the ballast results, reacting upon the machinery as well as the wood bed, to a much greater degree than where the train sways from one side to the other, as it would do in the case of breaking these joints. While on the subject of steel rails, I might mention that the New York and New Haven road is also trying them on a portion of their line; but they have not been down long enough to exhibit their superior economy over the iron rail.

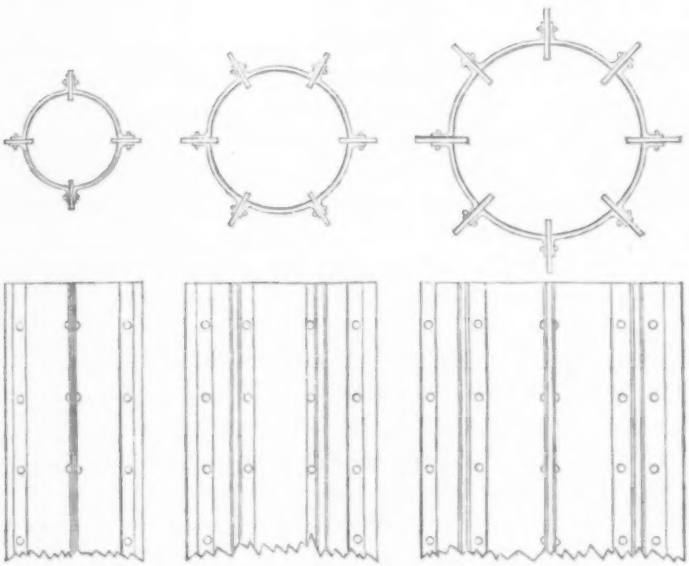
The borings to determine the character of foundation for Mr. Roebling's East River Suspension Bridge are now going forward on the Brooklyn side, under the direction of Geo. W. Plympton, Esq., C. E. The site of operations is just above the Fulton Ferry. The distance reached about this time is fifty feet, and the material presented is a mixture of hard pan gravel and boulders. As rock does not occur near the surface much under one hundred feet, it will be considered perfectly safe to found the abutments upon the first well demonstrated stratum of coarse gravel. I understand that Mr. Roebling has about completed his full plans for the work, and that they will soon be on exhibition.

That monstrosity, the "Harlam Bridge," which I noted in a former letter, is 486 feet between abutments, and has a width of 52 feet. The abutments are of expensive cut granite, and the piers are cast iron columns filled in with current masonry. The piers for the permanent spars are two in number, and are composed of five columns each, two of 8 feet in diameter, and the remaining ones six feet. They are sunk to a depth of 33 feet below the bed of the river, and 61 feet below high water mark. The swing span is a bow-string of 21 feet in length, and weighs 330 tons, supported on 96 rollers. The pivot pier has a diameter of 80 feet, and is composed of twelve cast iron columns, six feet in diameter, and a thickness of metal of 10 inches. Croton water is used to operate the draw mechanically. This work has cost over one million dollars. It is difficult to say what character

of bridge this is; perhaps it comes as near a clumsy bow-string girder as anything. The panels of the bow-string are filled in with perpendicular gothic mullions and cusps, and *beneath* the roadway of the permanent spans, an *imitation* cast iron arch is formed, the spandrils elaborated with the same style of architecture, only "more so."

A building will shortly be started in this city, which will be quite a novelty in the way of fire-proof construction. It will be an iron building throughout, the supporting principle being a *wrought iron* frame of columns and girders. The external facing is of cast iron but three-eighths of an inch thick, and the projectors claim to have the cheapest permanent building yet devised. It is surprising to contemplate the various applications of wrought iron at the present day, and how completely it is taking the place of cast iron. In the way of girders, cast iron is hardly thought of any more, although it is not many years since Mr. Hodgkinson elaborated the proper economical forms, with the idea that they were to be a permanent construction. From the failure of the Dee Bridge, the public have gradually been losing confidence in cast iron as a constructive material, except under certain conditions, and it has certainly been replaced by wrought iron beams of various forms. Cast iron columns, one would think, could not be improved upon, but even they are undergoing mutations even more striking than the innovation noted above. Perfection of wrought iron working is so nearly attained, that almost any work devised can be made from it. A peculiar case in point is wrought iron columns now being introduced under patent by the Phœnix Iron Company. The accompanying cuts fully illustrate their mode of manufacture. It will be noticed that there are three sizes, the four, six and eight segment columns, and by ranging the thickness of the radial pieces and segments, a range of resisting areas is presented that will meet any required case. The columns, as will be noticed, are made from rolled segments of cylinders with flanges, which flanges are brought together and riveted, or they may have filling pieces introduced, as shown in the wood-cut, to attain greater resisting power. They are more economical in every way than the cast columns, both in regard to the amount of metal used and the superior facilities for the fitting of girders in fire-proof work. The *exact* theoretical thickness being attained, their insuperable value for the posts and chords of bridges is apparent; for the weight is reduced to a minimum, and there is no risk of fracture from cross-bending. Most columns do not yield by absolutely crushing, but by bending or buckling,—and it seems almost

superfluous to dwell upon the superior merits of wrought iron under such circumstances. Cast iron columns have to be made with a great thickness of metal (far beyond theoretical requirements) to insure a sound casting as far as possible, and to allow for uneven thickness, unavoidable bubbles, cinder, &c., as well as to compensate for inequality of strain in the metal itself while cooling. It will be at once perceived that the advantage of these wrought iron columns in cheapness alone, over the cast iron ones, arises from the fact of their being so much lighter, not having an ounce of superfluous metal. The magnificent white marble and fire-proof building of Brown Bros. on Wall



Street is filled up with these columns, and they have been most artistically treated by the architect, Mr. Potter. A light cast iron band, with fillets, forms the capitals, while an appropriate base of the same material gives a finish to the whole. No effort is made (except on the first floor) to conceal the wrought iron construction, and the rendering is completed by bronzing the whole column. The whole effort is one giving confidence to the beholder, and the educated æsthetic is satisfied in a truthful rendering of a correct construction. These columns weigh but 45·5 pounds per foot, and the segments are of ¼-inch metal. In your own city, the rear walls of the imposing new Ledger Building are supported on eight segment wrought iron col-

umns, weighing 185·4 pounds per foot. The thickness of these segments is only seven-sixteenths, and the filling pieces is only five by five-eights. These columns are 20 feet high, and were tested in the Phœnix Iron Company's hydraulic machine up to 180 tons, the maximum capacity of the apparatus. There was no *effect* produced whatever, and as they had but 140 tons to carry, they were deemed perfectly safe. The area of this column was 55·6 square inches. It is to be regretted that there is no reliable data upon the resistance of wrought iron in the form of posts, columns, &c.; for what little experimenting has been done has shown most surprising results.

Modern Marine Engineering, by W. P. Burgh, which was issued in parts and recently completed, has been bound up as a complete work by Van Nostrand, and is now upon his shelves on sale. Mr. Burgh is a good engineer; but his *forte* does not lie in a literary direction. He is entirely too diffuse to render the letter-press of easy access in the way of reference. The real merit of this work consists in the profuseness of the wood-cuts and plates, and these last are alone worth the price of the book.

They are complete working drawings, with dimensions marked thereon, and, what is especially worthy of note, are properly colored, showing materials used in construction. The examples presented are of the most approved practice of such well-known firms as I. Penn & Sons, Maudsly & Sons, the Rennies, the Messrs. Napier, and James Watt & Co. What is given in the body of the work, in the way of engine-room fittings, superheating, combustion, condensation, expansion, &c., are mostly the result of the experiences of the above firms. On the whole, it is a work for constant reference for marine engineers, and must meet with a favorable reception from the profession.

A. P. B.

PETROLEUM FUEL.

PHILADELPHIA, *September 6th*, 1867.

Prof. Henry Morton.

DEAR SIR: As the use of *Fluid Fuel*, in the shape of Petroleum, is now urged upon the public, I wish to say a few words on the invention as presented in Philadelphia several years ago.

After repeated experiments with varied forms of apparatus, Mr. Thomas Shaw, of Philadelphia, in November, 1862, perfected and patented an invention "for using *combustible fluids* for the genera-

tion of steam," which plan was examined for several months by a special commission, consisting of Messrs. Wm. W. W. Wood, John P. Whipple and Alban C. Stimers, Chief Engineers of the U. S. Navy, who reported concerning the same in May, 1863, from which document I learn that—

"Anthracite coal of the very best quality was used alternately with the hydrocarbons for the same boiler, and as nearly as possible under precisely the same conditions and circumstances," and "the results gave for the crude petroleums an evaporation of 10·36 pounds of water per pound of oil, and for the mean of best anthracite coal 5·1 pounds of water per pound of coal, being a higher evaporation in favor of the petroleum of 103·1 per cent.

"The times of generating steam from water of equal temperature to 20 pounds pressure above the atmosphere, were for the oil an average of twenty-eight minutes, and for the coal sixty minutes, or a per centage in favor of the oil of 114·3 per cent; while the time from full operation for the complete extinguishment of the fire in the use of oil was about sixteen seconds."

This most flattering testimony, too, was elicited by a test manifestly unfair to the full merits of the invention; for the boiler used was so short, and "the volume of flame so great, as to pass entirely through the tubes of the boiler, and heat the smoke-pipe *red-hot* for several feet from its base."

These accomplished officers hereupon "earnestly" recommend a continuation of experiment on a practical scale, specifying that "one of our iron-clads or naval steamers, by its successful use as suggested in the experiments so far as trial, would be enabled to keep the sea under steam *two or three times as long*, with less labor and greater convenience, as compared with the use of coal, equal weights of each on board being considered."

This report is now more than four years old; but in accordance with it, a few days before the surrender of the Rebel armies, several government vessels were directed to be fitted out to use petroleum as fuel; and the sudden close of the war alone hindered this application of the invention.

The combustion apparatus is quite simple, not costly and easily adapted to every description of boiler, and the complete combustion of the fuel was undoubtedly obtained.

Such are the prominent facts of an important invention contrived by one of our own citizens more than five years ago. I present them

for your personal information, engaging to verify my statements whenever called upon.

Very respectfully, yours, HECTOR ORR.

P. S.—In some of our avowedly scientific periodicals, a doubt has lately been expressed against the use of petroleum as fuel because of its cost compared with that of coal. It should not be forgotten, that the amount of caloric *theoretically* derivable from a pound or ton of coal, is never practically realized, while the results laid down in the report of Messrs. Wood, Whipple and Stimers are literal facts. Mr. Shaw found the actual *cost* of oil fuel by his process not to exceed that of coal; and the accompanying advantages of the fluid fuel, viz: saving of space, saving of time (steam raised in twenty-eight minutes, fire put out in sixteen seconds), and the dispensing with an army of stokers, coal-heavers, &c., are so obvious as to barely require statement to secure consideration. H. O.

HOOSAC TUNNEL.

To the Editor of the Journal of the Franklin Institute.

SINCE I wrote my last article, I have again visited the Hoosac Tunnel, and find that the work is progressing more rapidly than ever before. In June they advanced the heading about 103 feet, and in July 131 feet. The contractors commenced operations August 1st, and one of the first things they did was to widen the heading from 15 feet to 24 feet, the latter being the full width of the tunnel; and yet with this increased width they advanced, up to the 25th of the month, at the rate of nearly 130 feet per month.*

They contend that they can advance faster with a wide than with a narrow heading; for the laborers can work to better advantage, and they make no more holes for a blast. The heading being wider, they can make the holes more inclined to the surface, and thus throw out the rock with less force. With a heading of 8 feet high and 24 feet wide, and an average advance of 5 feet per day, they will remove more rock daily than was done on an average in Mont Cenis from January to July of this year, unless they have recently enlarged their heading. Their heading was about 10 feet by 12 feet, and they averaged 7½ feet per day at the east end, and somewhat less at the west end. But the contractors hope soon to advance more rapidly than heretofore. D. V. W.

* Last advices, actual advance for August, 126 feet.

Civil and Mechanical Engineering.

(Continued from page 168.)

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

CHAPTER IV—Continued.

THE character of the gravel road, constructed as has been described, as to effective service when brought into use, remains to be spoken of. The following brief extracts from the annual reports are given, as presenting the progressive evidence that was developed from year to year upon this subject:

* "The surface of the gravel road finished with this intermixture (detritus and scrapings from broken stone heaps), has retained its firmness, under constant use, during several months."

† "As between gravel roads and MacAdam roads (and Telford roads as well), the experience of two to three years in the use of the two kinds upon the Park seem to have settled that the former are preferable for Park travel. Besides being less expensive in construction, the gravel roads are, so far as present experience indicates, less difficult and less expensive in maintenance, the surface longer retaining moisture in summer, and consequently requiring less attention in watering, and raising less dust than MacAdam roads. They are also more agreeable to travel on, both for carriages and horses, the difference being at once perceived in the greater ease of motion and less noise from wheels and hoofs, in passing from the MacAdam to the gravel road. The traction, which is usually rated higher upon gravel roads, is scarcely an appreciable element upon the easy grades of the Park roads.

"No plan of road, it is believed, is better adapted to park purposes, all things considered—cost, facilities of construction and maintenance—than the gravel road, constructed in the best manner, with the best materials.

"The portions of road of this kind constructed in 1860 (upon paved bottom), with screened gravel used in forming the last layer of the surface, have clearly surpassed, in all the more desirable characteristics, all other kinds of road that have been tried upon the Park. * * * These portions of road have withstood, under constant,

* Report of Superintending Engineer of January 1st, 1860.
† Do. do. do. do. 1862.

though not heavy travel, the heats of two summers, and the frosts, thaws and melting snows (the latter very trying to road surfaces) of one winter, without injury, with scarcely appreciable wear or loosening of surface or dust, and with but little attention to watering, and no repairs, being at all times smooth, firm and even, and very agreeable to travel on."

* * * * * *"The sample of road of eight hundred feet in length, finished with screened gravel, which was described in the last report, is also worthy of further mention. The merits of this kind of road surface have become still more obvious after two years' additional use.

"The length of time, now upwards of three years, that this sample has been in constant use, has afforded a fair test of its substantial qualities, as well as of its relative advantages in point of economy.

"The additional expense of using screened gravel, in the manner described, it is believed, is well repaid in the superior wear of the material and in the saving of expenses of repairs."

To these statements may be added now (1865) the results of one more year's observation. The last-mentioned piece of road of eight hundred feet in length, which is spoken of as a *sample*, because it was the first to receive a thorough finish with screened gravel, has had no renewing material added to it up to this date. It is now nearly five years since it was constructed and opened for public use, and during all that time it has required no repairs except at one point—on the shortest part of a curve, where, from the peculiar exposure consequent upon the turning of carriages, the surface of the gravel had become at times loosened and uneven, so as to require some attention. In other respects it has needed no renewing or special repairs. The roller has been occasionally passed over it after rainy weather, and it has been watered when dry, as in the case of the other kinds of road. It has been observed, however, that it needed less rolling, and is much less affected by rains and by freezing and thawing, than the other roads. The actual amount of wear has been very trifling and is quite remarkable, the surface still remaining well crowned and in nearly as true and perfect a condition as when first completed.

While other portions of the road have worn down from one to three inches *annually*, this has not worn to exceed one and a half inches in any part, during the whole time it has been in use; in other words, it would appear to be, within moderate bounds, *from two to three times as durable as the other roads.*

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* Report of Superintending Engineer of January 1st, 1864.

When this fact is taken into consideration, together with the comparative saving in the mere rolling and other expenses of maintenance (exclusive of the renewal of materials), and also the advantages derived from the possession of a superior road at all times, we have presented, in a very striking light, the merits of this kind of road.

In analyzing the causes that contribute to the greater durability of a road constructed in this manner, as compared with other gravel roads in which screened gravel is not used, and also with broken stone roads, we shall develop some points upon which opposing opinions prevail.

Gravel, for instance, has been held by some road-makers as being inherently a difficult, if not an impossible, material to make a superior road of. The rounded form of the pebbles (together, perhaps, with their too greatly polished surfaces, in some instances) has been the source of the difficulty. It has been supposed that the pressure of a wagon-wheel upon a pebble, surrounded by, and lying upon, or partly between, other pebbles, must necessarily have the effect to displace not only the one in contact with the wheel, but many others, each pebble acting somewhat as a wedge, under the weight of the wheel, to crowd away those in its vicinity. Results something like this have doubtless been observed, and it is easily understood that they must take place with gravel in its ordinary condition, especially when dry, for the pebbles, like round shot, piled on the top of each other, without any intervening substance to produce cohesion, must give way on the application of a slight pressure; but it does not follow that such results must take place under all conditions of practice.

The advocates of broken stone have also held that the flat sides of the stones, when brought into contact and adjusted together in a mass (as MacAdam's theory supposes), must cause them to lie more firmly, and to be less liable to jostle each other out of place, than in the case of rounded pebbles. This might be true if the contact and adjustment of the stones were of the perfect kind imagined, which practice shows is by no means the case. The results in the construction of the broken stone roads of the Park have been previously stated in illustration of this point.

As regards any failures that may have occurred heretofore in the construction of gravel roads, it is believed they are attributable to incompleteness of manipulation, or to inferior materials, or both, rather than to any inherent difficulty in the material itself.

The prominent points that are deduced from observation and experience in the use of the broken stone, and screened gravel roads are—

1st. That the rounded form of large pebbles (not too much polished by attrition), freed from the smaller particles and earthy matter, is peculiarly favorable to their strength to resist crushing, wear and abrasion, and to their packing and consolidation, through the intervention of the binding material; giving them, as compared with both gravel intermixed with the natural gradations of coarse and fine pebbles, &c., and angular broken stones, superior power to resist displacement. The pebbles being firmly held in place and prevented from slipping about and grinding upon each other, no practical wear takes place except on the surfaces actually exposed to contact with wagon-wheels.

2d. That the binding material employed, from its nature and the treatment it receives by powerful compression (the latter greatly aided by the rounded form of the pebbles), becomes in itself a firm and serviceable substance that contributes, in no inconsiderable degree, to the perfection of the wearing surface of the road.

3d. That, added to these circumstances, the gravel (in the special case of the Park roads) is of a hard and tenacious character, being the natural product of a species of fine-grained, compact stone, that is equal, if not superior in quality, to trap-stone, irrespective of the advantage of the rounded form.

Besides this, it must not be overlooked that there are characteristics possessed in common by the roads of the Park, constructed respectively with screened gravel, common gravel and broken stone, that contribute to the general successful results of the work.

The general cleanliness and coarseness of the body of gravel *below* the top or screened layer, and the freedom with which it is drained of water penetrating from the surface, together with the thorough drainage of the sub-pavement and of the ground below and adjacent, very much modify the disturbing and loosening action of frost, as well as of rain and sun.

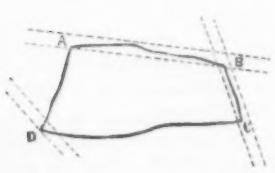
For the benefit of those who attach importance to a theory, as being necessary to confirm the results and deductions of experience, it will not be difficult to show that the foregoing points may be sustained (*a posteriori*) by a theoretical investigation.

The mechanical action of wagon-wheels upon the two kinds of stone—the broken and angular and the spherical or rounded—and upon the material associated with them, may be illustrated as follows:

A B being through the extremity instead of the centre of the stone, and hence the effect of the blow is, mainly, to sink the side of the stone next the wheel in its bed and tilt up the opposite side, as shown by the line E E, and, at the same time, giving the stone an impulse forward, and obliquely upward. As the wheel passes over the stone and leaves it, it imparts similar disturbing forces to it in a less degree in the reverse direction. It soon results from this that the bed of the stone becomes uneven, particles of dirt working down and insinuating themselves under it and gradually raising it up bodily, the enclosing material around the sides becoming loosened, and the space enlarged, until the stone, with some succeeding blow, and it may be a very slight one, is removed entirely from its place.

The comparison of a spherical stone with a cubical one of equal volume, as in the diagram, is much more favorable to the angular form than the comparison of a sphere or spheroid with the more practical forms of angular stones that have greater flatness than cubes; for, as the depth of an angular stone becomes less in proportion to its breadth of horizontal surface, its liability to displacement greatly increases. Also, the greater the breadth of surface of a flat stone, the greater is the area presented to the action of wagon-wheels, multiplying the chances of concussion, &c. It is further to be noted, that all angular stones with flat surfaces are subject to the action of wheels in the following manner, which is not common to spherical ones.

Let A, B, C, D represent the top surface of an angular stone; then the dotted parallel lines will show that a wheel may pass over the extreme corner of the stone, as at D, or it may pass along the extreme side, as at A B or B C, exerting in either instance a very effective displacing force that a spherical stone cannot be supposed to be liable to.

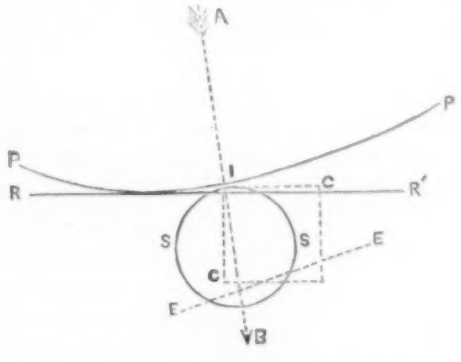


What is thus shown to be true of separate or isolated stones, is true, in a greater or less degree, of stones in the mass. If an angular or flat stone, lying in a detached position, is exposed to more numerous chances of displacement than a round one, it is also so exposed when aggregated with other stones of the same kind.

In the case of isolated stones that has been considered, the surrounding material constitutes the sole medium of resistance to displacement, and when the stones are aggregated, whether round or angular, the interposing material still constitutes mainly the resisting medium, but with the difference, that it is assisted by the stones themselves, in contact or in partial contact, with each other. This condition somewhat affects the nature of the problem, but if it is true that *the spherical form of stones is more favorable than the angular form to the effective packing and compression of the surrounding material*, which can scarcely be doubted, then it continues the advantage on the side of the rounded stones. Besides, it has been seen that

First. It is well-known by all who are observant of such matters, that an isolated round stone, embedded in the surface of a common road, retains its place much longer under the action of wagon-wheels than a flat or angular one, similarly situated, and also that the jolt, caused by a wheel in passing over the round stone, is usually felt more slightly than in passing over the angular one.

Let the circle S S in the diagram below represent a round stone (sphere) embedded in the surface of a road R R′, a portion of the top of the stone only, at I, being exposed above ground. P P represents a portion of the periphery of a wagon-wheel that is supposed to be moving in the direction R to R′. I is the point of contact of the wheel with the stone. The dotted line, A B, represents the direction of the radius of the wheel prolonged through the point of contact, &c.



It will be seen from this that the first impact of the wheel with the stone, at I, is with a force (in the direction of the radius) nearly perpendicular to the stone, and passing directly through its centre or axis, and that the main effect of the blow must be to settle the stone deeper in its bed rather than loosen it or cause it to rise or work upward. If any loosening effect is imparted to the stone, it is at least partially remedied by the action of the wheel in passing onward, and pressing the stone and the material in advance of it back into their former position. The repeated action of the wheel in this manner, in alternate opposite directions, *may*, after a while, so disturb the surrounding material—the stone being supposed, from some cause, to be prevented from sinking deeper—as to permit the stone to be displaced, but this doubtless occurs, in the majority of cases, from the gradual wearing down and washing away of the surrounding material.

Next, suppose the round stone to be removed from the figure, and the angular stone (cube), c c, represented by the dotted lines, to take its place, the angular stone to be considered in this case of equal volume or solidity with the round one. It will be seen that the wheel first strikes the angular stone on one corner, the direction of the force

angular stones, as they become flattened and depart from the form of cubes, have an increased liability to displacement, and if we examine broken stones as they are prepared for use in the construction of roads, we shall find that they depart very widely and materially from cubical forms. (This is not the usual supposition, but it is practically true.) The cubical form, even approximately, is the exception rather than the rule, the stones taking an almost infinite variety of other and less regular shapes, such as pyramids and wedges, more or less attenuated, or truncated pyramids and wedges, having acute angles, triangular sides, &c., &c. The consequence of this is that their tendency to cohesion and resistance to displacement are proportionably impaired.

It may be said that rounded stones also depart very much from their assumed forms; but this is not practically the case to the extent that prevails with angular stones artificially produced. Cobble stones, and the coarser pebbles of gravel, although they take the forms of spheroids, more or less elongated or flattened, nevertheless retain their distinctive spherical surfaces which govern, with a good deal of uniformity, the principles upon which they act or are acted upon.

It would seem, then, without further elaboration, that, *in theory*, no advantage can be made to appear in favor of broken or angular stones over rounded ones, in the formation of the *wearing surface* of roads; but, on the contrary, that strong reasons exist, founded on demonstrable principles, for giving the preference to the rounded or spherical forms. When this is sustained by ample experience and clear practical results, as in the case of the Park roads, there cannot much longer be any doubts remaining as to the utility and economy of using, instead of the material artificially produced, that which nature abundantly furnishes to our hands.

As it will be noticed that the use of screened gravel was not continued in the extension of the roads, after the completion of the portion of road last described, and the subsequent demonstration of its utility and striking economy, it is necessary to explain that this was owing to circumstances in no way affecting the merits of the question, but which were not under the control of the engineer.

[The preceding was written in the early part of 1865. Subsequently, during that year, in the completion of the last half mile of the Park roads, at the north end of the Park, screened gravel was again used. The opportunity was not afforded, however, on this part of the work, of making it in as thorough a manner as in the case of the first sample.]

Inferior gravel, taken from Park excavations, was to a considerable extent used, and the work was completed late in the season, when the